ing a number of photographs of Mars, which were secured with the 11-inch Draper telescope during the period March 31 to April 30, it was seen that no snow-caps properly so-called appeared until April 23. The photograph of March 31 showed clouds on both the terminator and the limb, but no polar caps. On April 23 a clearly visible and extensive light area appeared at the southern pole, but was not bright enough for snow, rather resembling an extensive region of clouds. A very small light area appeared near to the northern pole on April 15, but was only seen with difficulty. A visual examination with a 24-inch reflector revealed the southern polar cap on April 30 as extending far towards the north in long. 340°.

Prof. Pickering thinks that when the clouds disperse snow will probably be revealed lying in their place. He also contends that the observed seasonal colour-changes from brown to green on such features as the Mare Erythræum is the surest evidence of the existence of vegetation on Mars.

RECENT OBSERVATION OF EROS.—From an equatorial observation of Eros on June 12, in which the planet's position was referred to that of δ Capricorni, Prof. Millosevich determined the following position :—

(1905 June 12d. 14h. 32m. 24s. M.T. Rome).
α (app.) = 21h. 48m. 41·74s. δ (app.) = $-16° 41' 35''·3$
(*Astronomische Nachrichten*, No. 4029.)

STANDARD TIME IN VARIOUS COUNTRIES.—An interesting and useful summary of the present status of the use of standard time the world over is given in appendix iv., vol. iv., of the *Publications of the U.S. Naval Observatory*. The director of the observatory, Rear-Admiral Chester, has prepared various tables in which he shows the relation of the standard time employed in each country, state, or colony, to the meridians of Greenwich and Washington. In the first table is given a summary of nations that use standard time, and it shows that, of the thirty-six nations specifically mentioned, twenty employ Greenwich time as the basis of their systems. The areas and population concerned in these twenty nations form a very large majority of the totals, and of the remaining sixteen no two agree. This Mr. Chester regards as a powerful argument in favour of the adoption of a universal time system.

Other tables show in detail the present status of the time systems employed in a large number of localities, and enumerate the dividing lines separating those contiguous areas in which different standards are in use.

HARVARD COLLEGE OBSERVATORY ANNUAL REPORT.—In the forty-ninth annual report of the Harvard College Observatory Prof. E. C. Pickering, dealing with the year ending September 30, 1904, gives a brief outline of the progress made in each of the many and various researches which are being carried out at that observatory.

Variable stars and asteroids were photometrically observed, with the polarising photometer, by Prof. Wendell, who, *inter alia*, found that the asteroid [7] Iris varies about one-quarter of a magnitude in a period of 6h. 12m. The measurement of all the Durchmusterung stars in zones 10' wide at intervals of 5° was continued with the 12-inch meridian photometer, and the observations of many of the zones are now practically complete.

543 photographs taken with the 11-inch Draper telescope brought the total number secured with this instrument up to 15,030, and 1116 photographs were secured with the 8-inch Draper telescope, raising the total up to date to 32,094. It is proposed to extend this work to the spectra of the fainter stars by giving exposures of sixty minutes' duration and using only one prism. Many objects having peculiar spectra were discovered by Mrs. Fleming during the examination of the Draper photographs.

The Boyden and Bruce telescopes were employed continuously, and from the examination of the long-exposure chart plates Prof. Frost discovered many new nebulæ, &c., including 203 nebulæ in Virgo where the Dreyer (N.G.C.) catalogue mentions only 58.

The meteorological observations were continued at the Blue Hill Observatory, kites being employed on fourteen occasions. The average maximum height reached by the kites was 7750 feet above sea level, the maximum altitude attained on one occasion being 14,669 feet.

THE ACADEMIC SIDE OF TECHNICAL TRAINING.[1]

IT is not so very long ago that engineers, at any rate, became willing to recognise that technical training had an academic side at all. Almost the first, and still undoubtedly the greatest, representative of the academic side of our profession was the late W. J. Macquorn Rankine, who, after eighteen years of practical engineering experience, became professor of engineering in Glasgow in 1855, and held the chair until his death in 1872, and some of whose pupils have occupied, and now occupy, very high positions in the profession for which he did so much. Perhaps it may be said that Rankine was by nature rather a physicist dealing with engineering problems than an engineer (in spite of his love for the "three-foot rule"[2]) dealing with engineering problems. But only those of us who have had occasion carefully to study his work from the point of view of trying to teach subjects similar to his can ever know what an extraordinary physicist he was. But up to the years 1870 and 1880, Rankine's pupils and their contemporaries were not yet old enough to influence the body of the engineering profession, and there still existed a pronounced dislike on the part of an enormous number of engineers to anything academic, a dislike which can hardly be realised now by those who see the various professional bodies vieing with one another in their endeavours to ensure that their members shall have a proper and complete scientific training.

Now all the great engineering societies have recognised formally that no engineering training is complete without its academic side, and a very important committee, consisting of delegates from the five great engineering societies, with Sir William White as president, has been at work for some time, formulating their ideas as to the nature of the qualifying training, and going so far as to formulate also ideas as to the preliminary education of young engineers before they commence their academic training. I do not wish—rather I do wish very much, but it is not my subject to-day—to enter upon the very thorny questions involved in what that preliminary education ought to be according to the notions of a grown-up engineer. I will say, however, for it is no secret, that communications received from many headmasters of our great schools, while not going so far as some of us would like, are yet quite astonishingly radical in their ideas as compared not only with thirty, but even with fifteen years ago.

As to the general trend of our academic training, I think we engineers are entitled to say that it should be so arranged as best to train the best engineers. I put it in this way because I mean it to be understood that while on the one hand the *best* engineer is certainly not the man who knows his own business only and narrowly; on the other hand, I think we are entitled to demand that the engineer should not be looked upon as the mere bye-product of the training, but as the chief result to which other things are to be subordinated. I think that University College is not likely to fall into this mistake, but the point has really to be kept in mind in cases where, as here, the engineering education is only one branch of the wide range of education covered by the whole work of a university college.

In saying this, however, I particularly do *not* mean that the academic training of engineers should be laid out exactly on superficially utilitarian lines. The idea of giving a young man just as much mathematics, just as much physics, or just as much chemistry as the minimum that he can professionally require, is not only pernicious, but absolutely fallacious. I am sure that the only way of knowing a subject up to a certain point in such a fashion that, up to that point, it can be thoroughly utilised, is to study the subject up to a point very much further advanced. It is not at all a valid objection to the teaching of any particular point in mathematics or physics that it is more

1 Abridged from an Address delivered before the Union Society of University College, London, on June 29, by Dr. Alex. B. W. Kennedy, F.R.S.

2 Some talk of millimètres, and some of kilogrammes,
And some of décilitres, to measure beer and drams;
But I'm a British workman, too old to go to school;
So by pounds I'll eat, and by quarts I'll drink, and I'll work by my three-foot rule."

complicated or more advanced than anything which the engineer will be likely to require. That, in itself, is not an objection at all, because, as I have said, it is impossible really to master a scientific subject up to a certain, often very elementary, point without having at least a superficial knowledge of a much greater extent of the subject. But it is desirable, indeed necessary from our point of view, that the advanced work in purely scientific subjects should be specially chosen so as best to deepen and make certain the knowledge of the earlier work. This may be, and almost certainly is, a very different thing from choosing it so as to form the best basis for still further study of the particular science in question. In this connection I must point out—at least as my opinion—that it is a mistake to consider that there is only one mathematics or one physics, and that either the preparatory work or the whole teaching must necessarily be the same for everybody—for the man who is to devote himself to engineering, or for the man who intends to spend his life in physical work. For instance, I think an engineering student may be allowed to take for granted that A times B is equal to B times A (he is always quite prepared to believe it), and that it is perfectly reasonable to make to him dogmatic and probably in a sense erroneous, statements as to atoms (let us say) or as to the ether, without any of the qualifications which would be necessary supposing the atoms and the ether were to form the basis of the man's future studies.

It is no doubt a noble conscientiousness which sometimes prevents a man who is in the front rank among men of science from making to his students, as quite general, statements which he knows to be true only with qualifications or limitations. But the case is one in which often the general statement, given with authority, will really give the student a truer conception of the facts than a more accurate statement which is guarded by reasoning and explanations which he (that is, the student) cannot understand, and will almost certainly misunderstand. As a writer in NATURE put it a few days ago, referring to the theory of quaternions, "the truth is that very few students are able to appreciate to the full an absolutely logical argument until they have a certain amount of practical knowledge imparted to them more or less *by authority*."

There is one matter in connection with the teaching both of mathematics and physics to engineering students which I think might well be emphasised more than is generally the case. Whether it is desirable that it should be emphasised in dealing with the general student I do not venture to say. I mean the point that the answer to any question can only be as accurate as the data of that question. For the ordinary examination question in mathematical physics it is necessary and unavoidable to presuppose certain data which in real life are absurd and impossible. In the ordinary everyday questions of engineering there is nothing more misleading than to take for granted the data of the examination paper, and a very great deal of the disrepute into which mathematical work had fallen at one time among engineers was due to the fact that although the average student was able to use his methods rightly, he was unable to perceive whether they led him to a right result. I think it must be possible, even if it is not exactly easy, to point out to the student the extent to which the accuracy of his answers is influenced by the assumptions which he makes.

It is, I am afraid, too often presumed that the method of working out the answer is the chief thing; perhaps it may be from some particular point of view. But for our purposes, foolish as it may sound, the method of working out the answer is only secondary; the answer itself is the chief thing, and we really must have that answer right when it finds itself translated into steel or stone. We would much sooner have a right answer got by an imperfect method than a wrong answer got by the best method in the world. And an answer may be wrong in two ways; it may be wrong because the data are in themselves wrong, that is to say, inapplicable to the particular case, or it may be wrong by being stated in a form much more accurate than the real data will allow of, as when we find the indicated horse-power of engines given to six significant figures, when we know perfectly well that the fourth must always be doubtful.

It would be most useful if our scientific professors would discuss these points with their students and show them specially the extent to which the methods and theorems of the mathematician and the physicist may be properly applied when the only data available for the problems are such as actually are found in practice. It is hardly fair to leave the engineering professor to tell his pupils, or to leave the engineer to tell his assistants, that the methods they are using are quite inapplicable, and the results which they are getting obviously inaccurate. This is in every way inadvisable, and may lead the otherwise guileless student to discount all his teachers instead of only one. Every scientific experimenter knows that it is often the most difficult part of his work to say how alterations in data or want of knowledge of accuracy in data may affect the result, and I should like much to see this matter systematically dealt with by the teachers who have actually to do with the scientific or theoretical treatment of the questions concerned. If they have any doubt as to what is the general nature of the complex engineering questions which have to be solved, a letter addressed to any engineer in Westminster would bring them the fullest information. But happily most of the university colleges now have engineers on their Senates, so that the information can be had without going outside their own walls.

As to the more advanced part of engineering teaching in colleges, I want to put forward an idea that I have more than once had occasion to express. I should much like to see the development of some such connection between old and distinguished students of a college, who become later on older and more distinguished engineers, and the college at which they have studied or some other college, as exists in the similar case of the medical profession. My suggestion is that to get the full benefit from its best pupils, a college should, if possible, keep in touch with them after they have left it. A few years after they have left college, and when they have fairly got into the swim of professional work, but before they have so much lost touch with the difficulties of their college days that they no longer appreciate the student's point of view, they might be made to help in teaching by giving lectures on the special branches of engineering with which they were specially and actively familiar. They should do it before they have forgotten what they formerly learnt, or have had it driven out of their heads by the pressure of other ideas, and while college methods and points of view are still familiar. They would be men still making their way in their profession, still, let us hope, full of enthusiasm for their work, and certainly they would be daily finding out the differences between actual and academic problems. Teaching of this kind could in no way replace the general preliminary teaching of engineering subjects in the college, which must continue to be given, as it is given now, by a professor or professors, the bulk of whose time is spent at the college, and who are thoroughly in touch with all the students.

I confess that I hope a time will come when in any case professors of engineering will not remain permanently in academic harness, but will come out and take their place—a most important one—as colleagues among the active and leading engineers of the country, and will look upon such a position as that which they ought to reach rather than a solely academic position, however eminent. But, in addition to the work of the permanent professor or professors, I believe that old students coming back in the fashion I have indicated, not in one only, but in several branches of engineering, and giving short courses of special lectures to third year students, would very much help both the students and the rest of the teaching staff. The arrangement would also have the very great advantage of bringing about a closer and warmer connection between the men who are at work in their profession and the colleges where they were trained. It would also help to keep the colleges themselves in that actual and continual touch with engineering things and ideas which is so absolutely essential for their continued usefulness.

It will be noticed that the scheme I have outlined is closely analogous to the system already general in connection with medical training, where the lecturing and professorial staff on the technical side consists almost entirely of old students (occasionally from other colleges) who are beginning to make their way professionally, or who, by the time they have become professors, have actually made their way to the highest ranks of their profession.

HARVEY AND THE PROGRESS OF MEDICAL SCIENCE.[1]

AFTER some introductory remarks, Dr. Roberts referred to Harvey's work, and especially to his great discovery of what is commonly spoken of as the "circulation of the blood," though his published treatise is really on the "movements of the heart and of the blood." He re-affirmed their implicit belief in the absolute priority of Harvey's claim to this discovery, and spoke of its magnitude and far-reaching effects, which had been described in various and glowing terms, in no way exaggerated. Nor must they forget the formidable difficulties under which Harvey carried out his investigations; the profound errors which he had to combat and overthrow, and the confusion he had to clear away; his indomitable perseverance; and the masterly yet courteous manner in which he disputed and ultimately overcame the objections which had been raised against his views.

The orator then gave an outline of Harvey's career, dealing more especially with his association with the College of Physicians, where he held the position of Lumleian Lecturer from 1615 to 1656, in the very first course of lectures presenting a detailed exposition of his views concerning the circulation of the blood, which continued to form one of his subjects for several years. In the deed by which Harvey conveyed to the college his estate, he laid down three definite and distinct injunctions or instructions as to the subject-matter of the oration, which it was their duty to follow. The first injunction is that "there shall be a commemoration of all the benefactors of the said College by name and what in particular they have done for the benefit of the said College, with an exhortation to others to imitate these benefactors and to contribute their endeavours for the advancement of the society according to the example of those benefactors."

Dealing with this injunction, Dr. Roberts first mentioned individually Harvey himself; Thomas Linacre, the practical founder of the College of Physicians; and John Caius. He then considered generally as benefactors those who had held high office, alluding specially to that of President; those who had founded lectureships, or had given endowments for prizes, medals, or scholarships; those who had contributed to the library or to the general funds; and those who by their professional or scientific attainments and achievements, as well as by their high personal character, general culture and scholarship, and intellectual and moral qualities have shed unfading renown and lustre upon the College of Physicians.

In discussing the second injunction, namely, to "exhort the Fellows and Members of this College to search and study out the secrets of nature by way of experiment," the orator made a passing allusion in favour of vivisection, claiming for this method of investigation the cordial support of the medical faculty as a whole, with comparatively few exceptions. After referring to what the College had done as a body in advancing scientific research, he enlarged upon the great activity and promising aspects of modern research, more particularly in relation to subjects connected with the medical profession, and expressed his belief that Harvey would be amazed and fully satisfied were he to come on the scene at the present time, and realise the extent and thoroughness with which his exhortation is being carried into effect in all directions. Dr. Roberts then gave an abstract of what he had prepared for the oration with reference to the progress of knowledge and practice in connection with the circulatory system since Harvey's time, and the methods by which it had been brought about. He also directed attention to some of the more prominent examples of the beneficial results on an extensive scale of scientific and practical research, and alluded specially, as being closely connected with the circulatory system, to the "brilliant victories" which had been achieved against malaria in various parts of the world, many of them forming an integral part of this vast Empire. While paying a tribute of respect and admiration to all those who at the risk of life and health have gone forth to dangerous climates to study and fight against this and other tropical diseases, Dr. Roberts mentioned specially Dr. J. E. Dutton, the latest "martyr of science," as he had been aptly called, whose lamented death recently occurred on the Congo, where he had gone to study sleeping sickness on behalf of the Liverpool School of Tropical Medicine. He expressed on behalf of the college their deep sense of the great services which Dr. Dutton had rendered to the medical profession and to humanity, their profound regret at the premature cutting off of such a valuable life and promising career, and their heartfelt sympathy with his bereaved family and friends.

The orator concluded as follows:—The last and most agreeable duty laid upon me by Harvey's direction is to "exhort the Fellows and Members, for the honour of the profession, to continue in mutual love and affection among themselves, without which neither the dignity of the College can be maintained, nor yet particular men receive that benefit by their admission into the College which they might expect, ever remembering that *concordia res parvae crescunt, discordia magnae dilabuntur.*" With regard to the future position and reputation of this college in relation to scientific research and the progress of medicine, there can be no doubt or misgiving when we see amongst our younger fellows and members so many who are endowed with great abilities, who are full of energy, intellectual vigour, and enthusiasm in their work, and whose achievements have already brought them into conspicuous prominence and, in some cases, into the foremost ranks of our profession. May we not confidently hope that they will also ever keep in mind Harvey's last exhortation, and unflinchingly strive to maintain the high standard of character and conduct which he has placed before them? But should they at any time feel the need of an example, a stimulus, or an inspiration, let them steadily fix their attention and thoughts upon the personality, the life, and the work of our "immortal and beloved Harvey," whom it is our privilege and pride and happiness to commemorate on this anniversary.

[1] Abstract of the Harveian Oration delivered at the Royal College of Physicians on June 21 by Dr. Frederick T. Roberts.

HIGH TEMPERATURE RESEARCH ON THE FELSPARS.

AN elaborate investigation of the melting points of the felspars, devised and carried out by Messrs. Day and Allen in the physical laboratory of the United States Geological Survey, is described in a memoir just received.[1] The geological importance of laboratory research at high temperatures was strongly urged by the late Clarence King and Dr. Becker, and the well known work of Dr. Carl Barus has already furnished petrologists with a number of valuable data. The laboratory, discontinued in 1892 for want of funds, has been re-established by the exertions of Dr. Becker, and the piece of work before us has been in part subsidised by the trustees of the Carnegie Institution.

The authors describe in detail, for the benefit of other experimenters, the thermoelectric method by which they have been enabled to measure high temperatures with an error of not more than one degree. It was also found necessary to adopt some method of determining the instant of melting (where such exists) independently of the personal judgment of the operator. It appears that in

[1] "The Isomorphism and Thermal Properties of the Felspars." Part i. Thermal Study. By Arthur L. Day and E. T. Allen. Part ii. Optical Study. By J. P. Iddings. With an introduction by George F. Becker. Pp. 95; xxvi plates. (Washington, 1905.)